भारतीय मानक

Indian Standard

IS 12992 (Part 2) : 2023

स्प्रिंग भारित सुरक्षा मोचन वाल्व — विशिष्टि

भाग 2 परीक्षण

(पहला पुनरीक्षण)

Spring Loaded Safety Relief Valves — Specification

Part 2 Testing

(First Revision)

ICS 13.240

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भारतीय मानक ब्यूरो
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November 2023 **Price Group 6**

Chemical Engineering Plants and Related Equipment Sectional Committee, MED 17

FOREWORD

This Indian Standard (Part 2) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Chemical Engineering Plants and Related Equipment Sectional Committee had been approved by the Mechanical Engineering Divisional Council.

This standard has been formulated to cater to the testing of safety relief valve test to establish its operability at specified pressure and temperature.

This standard was originally issued in 1990. The present revision has been taken up with a view incorporating the modification found necessary as a result of experience gained in the use of this standard. Also, in this revision, the standard has been brought into latest style and format of Indian Standards, wherever applicable have been updated. BIS certification marking clause has been modified to align with the revised *Bureau of Indian Act,* 2016.

This standard is being issued in two parts, Part 1 covers design and Part 2 testing.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is compiled with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

Indian Standard

SPRING LOADED SAFETY RELIEF VALVES — SPECIFICATION

PART 2 TESTING

(First Revision)

1 SCOPE

This standard (Part 2) covers the test to establish the operability of safety relief valves at specified pressure and temperature.

2 PRESSURE TESTING AND INSPECTION

The pressure testing shall comply with this standard and be carried out by the safety valve manufacturer prior to any painting.

2.1 All pipes, connections and blanking devices, required for the test installation shall be capable of withstanding the test pressure.

2.1.1 Any temporary welded on attachments utilized for the purpose of carrying out the tests, shall be carefully removed after the tests and the resulting weld scars shall be ground flush with, the parent material. After grinding, all such scars shall be inspected by magnetic particle or liquid penetrant techniques.

2.1.2 All bourdon pressure gauges or other accepted pressure measuring devices fitted to test equipment shall be regularly tested and calibrated. The accuracy of the pressure gauge shall be ± 0.25 percent.

2.2 Medium of Testing

2.2.1 *Hydraulic or Pneumatic Testing for Strength*

a) Hydraulic testing is the preferred method in most of the applications;
b) Pressure testing with air or other suitable gas (to be avoided unless absolutely required) shall be carried out in place of the standard body hydraulic test with the agreement of all parties involved only in the following cases:
    1) Valves of such design and construction that it is not practicable for them to be filled with liquid; and/or
    2) Valves that are to be used in service where even small traces of water cannot be tolerated.

2.2.2 *For Pressure Setting of the Valve*

a) Gas or vapour service valves are to be set using air steam or nitrogen as the test medium; and
b) Liquid service valves may be set using water as the test medium.

2.3 Safety Requirements

2.3.1 *Hydraulic Testing*

2.3.1.1 The safety valve bodies shall be properly vented to remove entrapped air.

2.3.1.2 If material that is liable to failure by brittle fracture are incorporated into that part of the safety valve which is to be hydraulically tested then both the safety valve or part thereof and the testing medium shall be at a sufficient temperature to prevent the possibility of such failure.

2.3.1.3 Water of suitable purity shall be normally used as the test medium. Where other testing media are used (subject to agreement between the purchaser and the manufacturer), additional precautions shall be considered, depending on the nature of the liquid.

2.3.1.4 No valve or part thereof undergoing pressure testing shall be subjected to any form of shock loading, for example, hammers testing. Precautions shall be taken to ensure that test pressure is not exceeded.

2.3.2 *Pneumatic Testing*

No valve undergoing a pneumatic test shall be subjected to any form of shock loading, valves undergoing a pneumatic test should not be approached for close inspection until after the pressure raising has been completed. Precautions shall be taken to ensure that test pressure is not exceeded.

2.3.2.1 The hazards involved in pneumatic pressure

testing shall be considered and adequate precautions taken as follows:

a) If a major rupture of the valve should occur at some stage during the application of pressure, considerable energy will be released, hence no personnel should be in the immediate vicinity during pressure raising; and

b) The risk of brittle failure under test conditions shall have been critically assessed at the design stage and the choice of materials for valves, which are to be pneumatically tested shall be such as to avoid the risk of brittle failure during test. This requires provision of an adequate margin between the transition temperature of all parts and the metal temperature during testing. If the gas pressure is reduced to the valve under test from high pressure storage, then temperature will fall.

2.4 Test for Strength

2.4.1 The body seat of safety valves shall be blanked off and a test pressure of times the maximum pressure for which the safety valve is designed shall be applied only to the part of the body at the inlet side of seat.

2.4.2 Safety valves to be installed with a free discharge or where the only back pressure is build up back pressure, do not require a hydraulic test to be applied to that part of the valve on the discharge side of the seat. In case when a safety valve is to be subjected to a superimposed back pressure or valves on closed discharge systems then hydraulic test of times maximum back pressure on the valve shall be applied to those parts on the discharge side of the seat.

2.5 Duration of the Pressure Test for Strength

The test pressure shall be applied and maintained at the required pressure for a sufficient length of time to permit a visual examination to be made of surfaces and joints, but in any case, for not less than the times detailed in Table 1. For tests on the discharge side of the seat the testing time shall be based on the pressure specified in **2.4** and the discharge size.

2.6 Adjustment of Safety Valve Cold Differential Test Pressure

It is not permissible to adjust the cold differential test pressure of a safety valve using air, steam or nitrogen as the test medium, unless the safety valve has previously been subjected to the standard pressure testing and inspection.

Sl No.	*Set Pressure*	*Tolerance*
(1)	(2)	(3)
i)	0 Bar to 5 Bar	± 0.14 Bar
ii)	Over 5 Bar	± 3 percent

Table 1 Minimum Duration of Pressure Test for Strength

(*Clause* 2.5)

Sl No.	**Nominal Valve Size (DN)**	**Pressure Rating**		
	mm	Up to and Including 40 Bar	Over 40 Bar up to and Including 64 Bar	Over 64 Bar
(1)	(2)	(3)	(4)	(5)
			Duration in min	
i)	Up to and including 50	2	2	3
ii)	Over 50 up to and including 65	2	2	4
iii)	Over 65 up to and including 80	2	3	4
iv)	Over 80 up to and including 100	2	4	5
v)	Over 100 up to and including 125	2	4	6
vi)	Over 125 up to and including 150	2	5	7
vii)	Over 150 up to and including 200	3	5	9
viii)	Over 200 up to and including 250	3	6	11
ix)	Over 250 up to and including 300	4	7	13
x)	Over 300 up to and including 350	4	8	15
xi)	Over 350 up to and including 400	4	9	17
xii)	Over 400 up to and including 450	4	9	19

Table 1 (*Concluded*)

Sl No.	Nominal Valve Size (DN)	Pressure Rating		
	mm	Up to and Including 40 Bar	Over 40 Bar up to and Including 64 Bar	Over 64 Bar
(1)	(2)	(3)	(4)	(5)
xiii)	Over 450 up to and including 500	5	10	22
xiv)	Over 500 up to and including 600	5	12	24

NOTES

1 Sizes larger than 600 mm shall have testing time pro-rata.
2 1 bar = 10^5 Pa.

2.7 Bellows Test

A test shall be applied to the discharge side of those safety valves fitted with bellows to test the pressure tightness of the bellow and its joints. The bonnet vent, which shall be open, shall have a soapy water film placed across it and there shall be no visible leakage. The test shall be carried out using air or nitrogen at a pressure not less than the maximum specified back pressure. The duration of the test shall be as for the seat leakage test duration.

3 SEAT LEAKAGE TEST

3.1 Test Limitations

The seat leakage tests shall be carried out subsequent to the cold differential test pressure adjustment and shall comply with the following:

a) The leakage rate for the given type shall not exceed that given in Table 2, for valves with metal to metal seats, for cold differential test pressures not exceeding 70 bar; and

b) For cold differential test pressure greater than 70 bar the leakage rate specified in Table 2 shall be multiplied by the cold differential test pressure, in bar, divided by 70.

NOTE — Where resilient seats are incorporated in the seats or where greater tightness is required in the design the permissible leakage rate should be specified by the purchaser.

3.2 Test Apparatus

A blind plate is attached to the outlet connecting part, while the other parts except the outlet connecting part are completely closed. One end of a pipe, 8 mm outside diameter and 6 mm bore, is attached to the blind plate and other end is held at a position 13 mm below water level.

NOTE — A typical test apparatus for determining seat tightness of a closed bonnet safety valve is shown in Fig. 1.

3.3 For a safety valve with an open bonnet or an exposed spring, the seat leakage test shall be conducted by placing a dam over the lower half of the outlet flange and flooding the valve body to submerge the seat faces. The leakage rate across the seat faces shall not exceed those specified.

3.4 Test Procedure

With the valve mounted vertically, as shown in Fig. 1, the leakage rate in bubbles per minute shall be determined with pressure at the safety relief valve inlet held at 90 percent of the set pressure immediately after popping, except for valves set at 3.5 bar or below, in which case the pressure shall be held at 0.35 bar below the set pressure immediately after popping.

3.5 Minimum Test Duration

The test pressure shall be applied for a minimum of 1 min for valves up to and including DN 50, 2 min for valves above DN 50 up to and including DN 100 and 5 min for valves above DN 100. Air or nitrogen at approximately atmospheric temperature shall be used as the pressure medium.

3.6 Permissible Leakage Rate

The allowable leakage rate shall not exceed the values given in Table 2.

4 PERFORMANCE TESTING

Type testing of safety valves for operating and flow characteristics using steam, air, water or other gases or liquids of known characteristics.

Table 2 Seat Leakage Rates

(*Clauses* 3.1 *and* 3.6)

Sl No.	Type	Permissible Flow Area mm^2	Seat Leakage Rates Bubbles of Air or Nitrogen per Minute at 90 percent of Cold Differential Test Pressure
(1)	(2)	(3)	(4)
i)	Balanced bellows	*F* and smaller	50
		G and larger	30
ii)	Conventional	*F* and smaller	40
		G and larger	20

4.1 General

This clause applies to the types of safety valves as defined in Part 1 of this standard.

4.1.1 *Carrying Out of Tests*

The tests to determine the operating characteristics shall be in accordance with **4.2** and the tests to determine the flow characteristic shall be in accordance with **4.3**. When these tests are carried out separately, the parts of the valve, which influence fluid flow, shall be complete and installed in the valve.

4.1.2 *Object of Tests*

To determine under specific operating conditions particular characteristics of the valves before opening, while discharging and at closing. The following characteristics shall be determined:

a) Set pressure;
b) Reseating pressure;
c) Blowdown;
d) Reproducibility of valve performance;
e) Mechanical characteristics of the valves determined by seating or hearing such as:
   1) Ability to reseat satisfactorily; and
   2) Absence or presence of chatter, flutter, sticking and/or harmful vibration.
f) Relieving pressure; and
g) Lift at the appropriate over pressure.

4.1.3 *Procedure for Testing*

The purpose and manner of testing shall be such as to provide suitable data from which the operational and flow characteristics are determined. To this end the following information shall be supplied to the independent authority, and shall be approved before testing is undertaken:

a) Full particulars of the valve to be tested and the range of valves and springs which they present;
b) Proposed source, capacity, pressure, temperature and properties of the test fluids; and
c) Details of the test including proposed instrumentation test and calibration procedure.

4.1.4 *Result Calculated from Test*

The theoretical flowing capacity is calculated as per standard formulae and using this value together with the actual flowing capacity at relieving pressure the coefficient of discharge of the safety valve is calculated.

4.2 Tests to Determine Operating Characteristics

4.2.1 *Carrying Out of Tests*

The set pressure at which the operating characteristics are determined shall be the minimum set pressures for which the spring used is designed. Valves designed to discharge gases or vapours shall be tested using steam, air or other gas of known characteristics except that, valves for steam service should be tested on steam. Valves for liquid service shall be tested on water or liquids of known characteristics. The allowable tolerances or limits, as applicable, on these characteristics are as follows:

a) Set pressure: below 5 bar ± 14 bar
   : 5 bar and above ± 3 percent;
b) Lift ± 5 percent of the average for a given size of valve;
c) Limits of adjustable blowdown: 2.5 percent of set pressure minimum, 7 percent of set pressure maximum, except for valves having:
   1) Seat bore less than 15 mm when the maximum limit of blowdown shall be 15 percent of set pressure; and
   2) For values of set pressure less than 3 bar when the blowdown shall be a maximum of 0.3 bar;

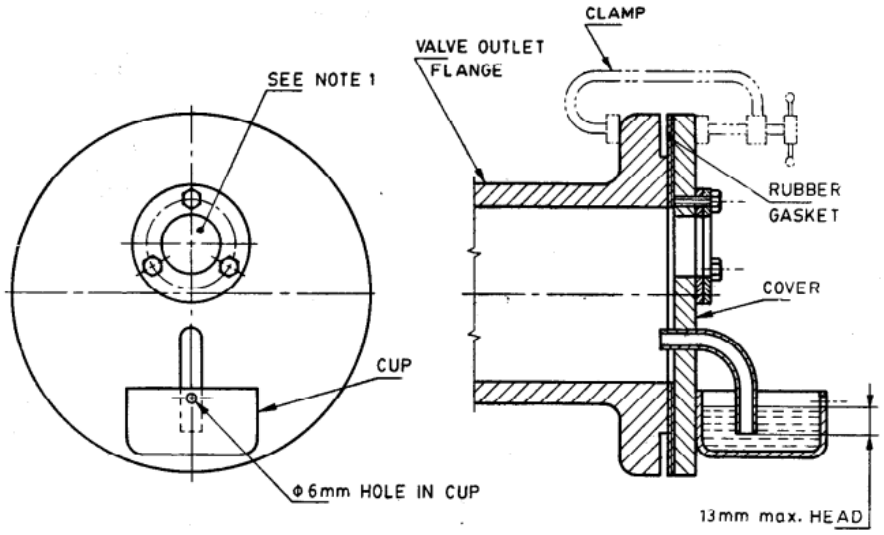
d) Limits for valves with non-adjustable blow down maximum 15 percent of set pressure; and

e) Limits of blowdown for incompressible fluids.

Maximum 20 percent of set pressure. For values of set pressure less than 3 bar, the blowdown shall be a maximum 0.6 bar.

4.2.2 *Test Equipment*

The error of pressure measuring equipment used during the test shall be not more than 0.5 percent of full-scale reading, with the test pressure within the middle third of the instrument range.



NOTES

1 Opening covered with a suitable membrane to relieve pressure if valve should open during test. It is essential that the opening is securely sealed against leakage.
2 When using this fixture all other outlets shall be sealed.

FIG. 1 TYPICAL TEST RIG FOR DETERMINATION OF VALVE LEAKAGE RATES

4.2.3 *Valve Used in the Test Programme*

The safety valves tested shall be representative of the design, pressure and size range of valves for which operating characteristics are required. To be representative, the ratio of valve inlet to flow area and the ratio of flow area to valve outlet shall be taken into account.

4.2.3.1 Tests shall be carried out on three sizes unless the size range contains not more than six sizes, when the number tested may be reduced to two. When the range is extended from a number less than seven to a number equal to or in excess of seven, then tests on three sizes of valves shall be carried out.

4.2.3.2 When the range is extended so that previously tested safety valves are no longer representative of the range, further tests shall be required.

4.2.4 *Test Procedure*

The test shall be carried out using three significantly different springs for each size of valve. Where three test pressure are required from one valve size, it is permissible to test either one valve with three significantly different springs or three valves of the same size at three significantly different settings in order to comply with the requirements.

4.2.4.1 Each test shall be carried out a minimum of three times in order to establish and confirm acceptable reproducibility of the performance.

4.2.4.2 In the case of valves of special designs of which one size only at one pressure rating is being manufactured, test at that set pressure shall be carried out.

4.2.4.3 In the case of valves, of which one size only at various pressure rating is being manufactured,

tests shall be carried out using four different springs, which shall cover the range of pressure for which the valve shall be used.

4.3 Test to Determine Flow Characteristics

4.3.1 *Carrying Out of Test*

For safety valves designed to discharge gas/vapour, after operating characteristics have been satisfactorily established, it is acceptable to use steam, air, or other gas of known characteristics as the fluid for flow characteristics.

4.3.1.1 When discharged quantities are being assessed using a fluid other than that used for the operating characteristics tests, the valve disk shall be mechanically held at the same lift as that obtained at the same over-pressure.

4.3.1.2 It is not permissible to use steam, air or other gas for flow characteristics tests for a liquid safety valve or liquid for the flow characteristics tests of a gas/vapour valve.

4.3.2 *Valves Used in the Test Programme*

The safety valves tested shall be representative of the design, pressure and size range of valves for which flow characteristics are required. Tests shall be carried out on three sizes, unless the size range contains not more than six sizes, when it is permissible to reduce the number tested to two. When the range is extended from a number less than seven to a number equal to or in excess of seven, then tests on three sizes of valves shall be carried out.

When the range is extended so that the previously tested safety valves are no longer representative of the range, further tests shall be carried out.

4.3.3 *Test Procedure*

4.3.3.1 On each of the valves to be tested as required, flow characteristics tests for determination of the coefficient of discharge shall be carried out at three different pressures.

4.3.3.2 In all cases the size and pressure range shall be representative of the design range, within limits of the testing facility.

4.3.3.3 In these cases where the size of the valve is greater than can be flow tested at the test facility, the independent authority shall, at its discretion subject to feasibility and opportunity, require one confirmatory flow test at the location of the installation and require the proper function of at least one valve of the design to be demonstrated by test. However, three geometrically similar models of different sizes may be used to determine the coefficient of discharge. The proper function of at least one valve of the design to be certified shall be demonstrated by test.

4.3.3.4 A curve may be established for the coefficient of discharge versus valve lift at a given inlet pressure and where applicable the appropriate blowdown ring(s) position. Coefficients of discharge for intermediate positions of lift may be interpolated from this curve. Tests shall be conducted to establish the variation of the coefficient of discharge with inlet pressure and relevant blowdown ring(s) position. If no variation occurs, the curve may be used as described, however, if the variation is noted, tests shall be required by the independent authority to establish additional curves for these variables.

4.3.4 *Test Techniques*

The test techniques adopted shall be either of the following:

a) The valve configuration shall be the same as that used during the test for operational characteristics, that is, the lift and if a blowdown ring(s) is fitted, its position shall be the one(s) established for the particular size and over-pressure during operating characteristic testing. Average values of the lift shall be used when the tolerances of **4.2.1** have been met; and

b) Instead of the above it is permissible to establish curves of capacity versus valve absolute inlet pressure as a function of lift and blowdown ring position. These curves may then be used to obtain the unique value desired based on the results of the operational testing.

4.3.5 *Tests on Valves of Special Design*

For the cases of valves of the special design of which one size only at various pressure ratings is being manufactured, tests shall be carried out at four different set pressures which shall cover the range of pressure for which the valve will be used or as determined by the limits of the test facility. The discharge capacities as determined by these four tests shall be plotted against the absolute inlet pressure, and a straight line drawn through these four points and zero-zero. If all points do not lie within ± 5 percent of this line, additional testing shall be required by the independent authority until the line is established without ambiguity. For liquids, the capacities determined by the four tests shall be plotted on log-log paper against the differential (inlet pressure-back pressure) test pressure and a straight line drawn through these four points.

4.3.6 *Test Result*

In all methods described for flow characteristic testing, all results shall be ± 5 percent of the average or additional testing shall be carried out until this criterion is met.

4.3.7 *Adjustment During Test*

No adjustment to the valve shall be made during the test. Following any change or deviation of the test conditions, a sufficient period of time shall be allowed to permit the rate of flow, temperature and pressure to reach stable conditions before readings are taken.

4.3.8 *Records and Test Results*

The test records shall include all observations, measurements (in SI units), instrument readings and instrument calibration records (if required) for the objective(s) of the test. Original test records shall remain in the custody of the test establishment, which conducted the test. Copies of all test records shall be furnished to each of the parties of the test. Corrections and corrected values shall be entered separately in the test record.

4.3.9 *Flow Test Equipment*

The test equipment shall be designed and operated in such a way that the actual test flowing capacity measurement shall be accurate to within ± 2 percent.

4.4 Certified Capacity of Valves

4.4.1 The certified capacity of the valve shall be 90 percent of the capacity determined by the test. For valves using the coefficient of discharge method, the certified capacity shall be 90 percent of the theoretical capacity times the coefficient of discharge.

4.4.2 It should be noted that the coefficient of discharge method shall not be used to calculate the capacity at a lower over-pressure than at which the test was carried out although it can be used to calculate the capacity at a higher over-pressure.

4.5 Special Tests

Vendor to perform any other special tests like NDT, chemical analysis, etc (other than indicated in this standard), as specified by the purchaser.

5 APPEARANCE OF SAFETY VALVES

The appearance of safety valves shall be in accordance with the following:

a) Casting shall be smooth on both inside and outside faces and be free from harmful blowholes, flashes, and burning, and inclusion, cracks, laps, etc;
b) Machine worked faces shall be free from harmful flaws, uneven finish, etc;
c) Working surface of the valve disk with valve seat shall be free from blowholes and other flaws;
d) Corners and edges without designation of dimension shall be properly rounded; and
e) Each moving part shall be so assembled also be suitable for operation.

6 MARKING

6.1 Spring loaded safety valve shall be marked with manufacturer's name or his recognized trade-mark, identification mark, and with any other information required by purchaser.

6.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: MED 17 (21869).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi